

The five kingdoms of living organisms

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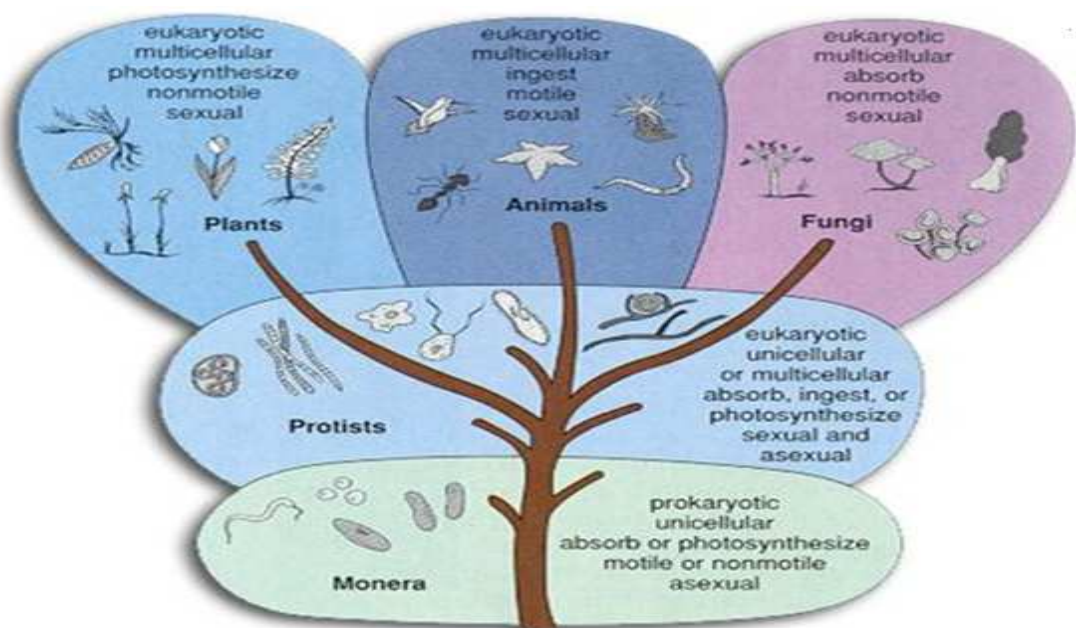
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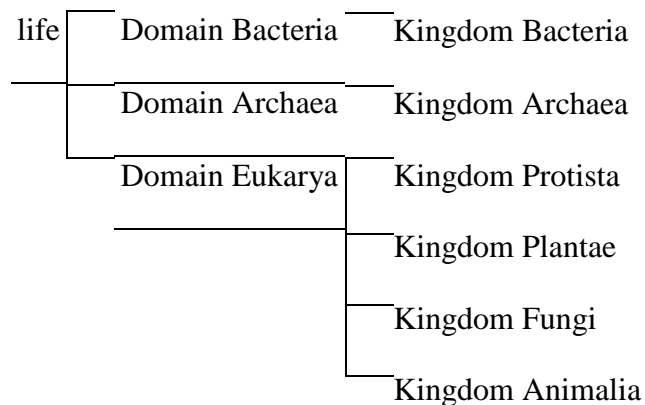
1 The system of classification

The five kingdom system is the most common system of classification of forms of life in use today; it descends from the Greek philosopher Aristotle (384 B.C. to 322 B.C.) but it was **Carlous Linnaeus** (1707-1778), the “Father of Classification” who divided the living organisms into two kingdoms – Animalia for animals and Vegetabilia for plants (Linnaeus also included minerals, placing them in a third kingdom, Mineralia). He also divided each kingdom into classes and introduced the Binomial System of nomenclature. The five kingdoms classification was introduced by Robert. H. Whittaker in 1969. He classified the living organisms into: Monera, Protista, Mycota, Metaphyta, Metazoa.

According to this classification, Monera represent the earliest group of organisms. The monera are thought to have given rise to Protista from which the three other kingdoms of organisms evolved along separate lines. Fungi were the first to appear from Protista. Later, about a billion years ago some protists must have evolved into primitive multicellular animals. Still later, probably about 350 million years ago, some protists must have evolved into higher forms of plants.



The five-kingdom classification has certain merits and demerits but it is largely the most accepted system of modern classification mainly because of the phylogenetic placing of different groups of living organisms. However, the system is complicated by the discovery of archaebacteria; some references place the archaebacteria in a separate division within the kingdom Monera, and others, the most recent, recognize them as a 6th kingdom. To accommodate the archaebacteria, Woese¹ attempted to establish a "three primary kingdom" or "urkingdom" system; the name "domain" was proposed for the highest rank. The six-kingdom system shown below represents a blending of the classic five-kingdom system and Woese's three-domain system. Such six-kingdom systems have become standard in many works.



2 The five kingdoms

The five-kingdom classification gives a clear indication of cellular organization and modes of nutrition, the characters which appeared very early in the evolution of life.

The kingdoms Monera and Protista include diverse, heterogeneous forms of life. In both the kingdoms there are photosynthetic (autotrophic) as well

¹ (Woese et al: 1990)

as non-photosynthetic (heterotrophic) organisms. Both include organisms which have cells with cell wall as well as without cell wall.

None of the three higher kingdoms include a single ancestor of all its forms. Multicellular lines have originated from protists several times (polyphyletic).

Viruses have not been given proper place in this system of classification.

The typical characteristics given when describing the five kingdoms are: structural organization, method of nutrition, types of organisms, number of named species and an estimate of the total number of species.

2.1 Monera

- Structural organization: small, simple single prokaryotic cell; some form chains or mats.
- Method of nutrition: they absorb food and/or photosynthesize.
- Types of organisms: bacteria, blue-green algae, and spirochetes.
- Number of named species: 4,000.
- Total number of species: 1,000,000.

Some researchers² divide the Monera into two distinct kingdoms: Eubacteria (the true bacteria) and Archaeobacteria (bacteria-like organisms that live in extremely harsh anaerobic environments such as hot springs, deep ocean volcanic vents, sewage treatment plants, and swamp sediments) but we will follow classifications which accommodate the archaeobacteria in a separate domain or superkingdom, so we will not include archaeobacteria in this kingdom. What we are going to describe in this section would be called kingdom bacteria in the new six kingdom system.

² Kingsley R. Stern (Introductory Plant Biology, 8th Edition, 2000)

The kingdom Monera includes most organisms with a prokaryotic cell organization (that is, no nucleus). For this reason, the kingdom is sometimes called Prokaryota or Prokaryotae.

All organisms in the Kingdom Monera are prokaryotes. They lack nuclei and organelles and most of their cell walls are made of peptidoglycan (the exceptions are the archaeobacteria). Most utilize flagella for movement. Circulation and digestion are accomplished through diffusion.

2.2 Protista

- Structural organization: large, single eukaryotic cell; some form chains or colonies.
- Method of nutrition: they absorb, ingest, and/or photosynthesize food.
- Types of organisms: protozoans and algae of various types.
- Number of named species: 80,000.
- Total number of species: 600,000.

Grouping of all unicellular eukaryotes under the kingdom Protista has solved many problems, particularly related to the position of organisms like Euglena. Members of the kingdom Protista, also called Protoctista are not animals, which develop from an embryo called a blastula; they are not plants, which develop from an embryo that is not a blastula but is retained in the mother's tissue; they are not fungi which develop from spores and lack cilia and flagella (called undulipodia) at all stages of development; they are not monerans, which have prokaryotic cells.

The kingdom Protista includes diverse organisms, from minute flagellated cells to macroscopic kelp. All members have nucleated cells and live in aquatic habitats (freshwater and marine). According to Lynn Margulis, K.V. Schwartz

and M. Dolan (1994), the cells of all Protoctista originally formed by bacterial symbioses (symbiogenesis).

Protists are grouped according to whether they are animal-like, plant-like, or fungus-like.

2.3 Fungi

- Structural organization: multicellular filamentous form with specialized eukaryotic cells.
- Method of nutrition: they absorb food.
- Types of organisms: fungi, molds, mushrooms, yeasts, mildews, and smuts.
- Number of named species: 72,000.
- Total number of species: 1,500,000.

Elevation of the group fungi to the status of a kingdom is justifiable since fungi totally differ from other primitive eukaryotes like algae and protozoans.

In general, fungi are parasitic or saprophytic, and have cell walls made of chitin. Digestion is extracellular. Circulation, respiration, and excretion occur through diffusion. Reproduction can be asexual through spores or sexual where strains of fungi meet.

Some members of the Kingdom Fungi are associated with algal cells of the Kingdom Protista and/or prokaryotic cyanobacteria of the Kingdom Monera. This complex symbiotic, mutualistic relationship is called lichen. Lichens are essentially lichenized fungi containing unicellular monerans and/or protists.

2.4 Plantae

- Structural organization: multicellular form with specialized eukaryotic cells; they do not have their own means of locomotion.

- Method of nutrition: they photosynthesize food.
- Types of organisms: mosses, ferns, woody and non-woody flowering plants.
- Number of named species: 270,000.
- Total number of species: 320,000.

In general, all plants have chlorophyll, cell walls of cellulose, and tissues and organs. Biologists have theorized that plants evolved from algae since both plants and algae have chloroplasts with chlorophyll, cell walls of cellulose, glucose stored as starch, and alternation of generations.

The plant kingdom includes nonvascular and vascular plants. Nonvascular plants lack a water-conducting system of tubular cells (called xylem tissue), and do not have true roots, stems and leaves.

Plants are classified in the following divisions: bryophyta, tracheophyta, terophyta, coniferophyta and anthophyta.

2.5 Animalia

- Structural organization: multicellular form with specialized eukaryotic cells; have their own means of locomotion.
- Method of nutrition: they ingest food.
- Types of organisms: sponges, worms, insects, fish, amphibians, reptiles, birds, and mammals.
- Number of named species: 1,326,239.
- Total number of species: 9,812,298.

Animals are heterotrophic organisms with organs or tissues. Most are mobile or have a mobile life stage. All have a larval or embryonic stage of development.

They exhibit different kinds of symmetry: asymmetry, spherical, radial, and bilateral.

They can be invertebrates (no backbone) or vertebrates (with backbone).

There are more species than all the other kingdoms combined; more than half of all animal species are insects (800,000 species), and beetles (300,000 species) comprise the largest order of insects (one fifth of all species based on a total of 1.5 million); if all the species of plants and animals on earth were lined up at random, every 5th species would be a beetle.

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